

DR ELIZABETH N. MARKS AO: MOSQUITO STUDIES 1940–1976

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Abstract

The early scientific life of Dr Elizabeth Nesta ('Patricia') Marks is reviewed which, in some small measure, explains why she was such a remarkable person who dominated the Australian mosquito world for an extended period. With her typical thoroughness and her interest in history, Pat collaborated with Kathleen Cummins to produce a comprehensive record of her life in *Mosquitoes and Memories – Recollections of 'Patricia' Marks*, published in 2004, and required reading for anyone interested in the history of science in Queensland.

Patricia Marks was born into a family with a passionate interest in science, particularly the natural sciences. She grew up surrounded by people who knew the names of plants and animals. Her father, E.O. Marks, was a highly regarded geologist before turning to medicine. It is interesting that, on graduating in 1916, he joined the Royal Army Medical Corps and served in the trenches in France, about one year prior to Ian Mackerras (Fig. 1) who, then a gunner in the A.I.F., was to become one of Patricia's mentors. Ian was gassed at Villers Bretonneux in May 1918. Fortunately for Australian science, his resulting blindness was only temporary.



Fig. 1. Dr E.N. Marks and Dr I.M. Mackerras at the International Congress of Entomology, Canberra 1972.

That Pat was an outstanding scientist is not surprising. Her grandfather joined the Royal Society of Queensland in the year it was founded (1854) and became an Honorary Life Member. Her father also became President and an Honorary Life Member of the Society, as did Patricia. While the central thrust of Pat's scientific career was mosquito research, she had a much broader interest in science, stimulated by the number of scientific societies of which she was an active member (Monteith 2006), a habit inherited from her family.

Patricia speculated that her interest in entomology was sparked on a Queensland Naturalists' Club outing in 1927, when she was 9 years old (Marks and Cummins 2004): 'I was fascinated watching him using his net to catch butterflies and other insects and that perhaps started my interest in insects'. The entomologist being watched was Rowland Illidge, a name familiar to mosquito control workers since the endangered *Acrodipsas illidgei* (Waterhouse & Lyell) [Illidge's ant-blue butterfly (family Lycaenidae)], named after him, occurs in mangroves.

One of Patricia's strengths which, I suspect, stemmed from her early training, was the keeping of a diary. This enabled her to produce the detailed accounts which are characteristic of her work. I recently read her 'Diary of Trip to Ingham and Cairns District 1946'. This was one of her early investigations on behalf of the Queensland Department of Health and was a response to a malaria outbreak at Lucinda Point. The account starts on Monday, May 13, when Patricia left Roma Street Station at 8 pm and, 98 closely written pages later, finishes at 8 am on July 12, when she returned to Brisbane. Included is a fascinating account of how an investigation of an outbreak of an insect borne disease should be conducted.

Pat's primary duty with the Mosquito Control Committee (initially as Graduate Research Assistant, later as Senior Research Fellow and finally as Senior Research Officer), until its disbandment, was concerned with research into the taxonomy and biology of mosquitoes of Australia and New Guinea.

In 1939, Pat joined the staff of the University of Queensland medical school, as assistant curator of the pathology museum. She also demonstrated to students in F.A. Perkins' medical entomology course. In 1943, the Queensland Government set up a Mosquito Control Committee: Sir Raphael Cilento, Director General of Health, was chairman, Mr F.A. Perkins, lecturer in entomology, was the secretary, and Miss E.N. Marks was graduate research assistant and its employee. This gave Pat a laboratory to work in at the George Street campus of the University of Queensland (Fig. 2), a salary, and numerous field trips to investigate mosquito problems around the state. This arrangement continued until 1973, when the committee was disbanded. Unfortunately, the grant had never provided for an assistant which would



Figs 2-3. (2) E.N. Marks examining a new mosquito light trap with University of Queensland colleague, Elizabeth Exley, around 1960. (3) E.N. Marks sampling larvae from water in a canoe on the Mamberano River in then Dutch New Guinea in 1958.

have relieved Pat of much of the routine mechanical work and allowed her to concentrate on systematics.

After her appointment in 1943, Pat worked with F.A. Perkins, who was then the officer commanding the Australian Army's Land Headquarters School of Malaria Control. At the time, Allied troop casualties due to malaria in the Pacific outnumbered battle casualties by from 4 to 14 times, depending on the theatre. The malaria control workers trained at F.A. Perkins' School played an important part in reducing malaria casualties. A valuable spin-off from this work was interaction with U.S. Army entomologists, both then and in post-war years. These included Willard V. King, Harry Hoogstraal and John Belkin. Belkin's important '*Mosquitoes of the South Pacific*', published in 1962, greatly influenced Pat's work; she was later to be awarded the Belkin Medal, a prestigious award for mosquito workers, in 1986. Pat was also able to interact with the Australian entomologists David Lee and Tony Woodhill.

As the State Health Department's only full time mosquito expert, she was required to investigate suspected outbreaks of mosquito-borne disease and the occurrence of unusual numbers of mosquitoes. These investigations required close liaison with local Councils. Pat rapidly became the first port of call for Local Authorities requiring advice on mosquito control and the identification of species collected. She played a major role in the *Aedes aegypti* (L.) eradication campaign mounted in southeast Queensland in the mid 1950s, which saw the disappearance of both the vector mosquito and the outbreaks of dengue fever frequently recorded in Brisbane.

Pat's official duties saw her traversing Queensland from Torres Strait to the Tweed and from Fraser Island to the Gulf and the Northern Territory. The collections made during National Mosquito Control Committee investigations were supplemented by collections made on Queensland Naturalists' Club outings, all of which resulted in collections of mosquitoes, often giving new locality records and, sometimes, new species. I doubt that any one person has collected mosquitoes from as many localities in Queensland as Pat Marks. In making my own collections in remote areas, I was often told that 'the lady Doctor from the University' had been there several years before me.

It should be noted that, for much of the period between 1940 and 1976 when Pat was working in the north, particularly prior to 1960, the common means of transport was by non air-conditioned rail or by equally uncomfortable motor vehicle. There was no GPS system to tell you where you were plus or minus 4 metres; there were no readily available aerial photographs; there were no radios in vehicles to call for help if you were bogged or if the vehicle broke down; there were no air-conditioned motels and, when they existed, country hotels were primitive by modern standards, so the 'lady Doctor from the University' often had an uncomfortable time in the field.

In later years Pat ran courses in mosquito taxonomy, biology and control for health inspectors, teachers and mosquito control workers in Queensland. This gave her a broad range of collectors spread throughout the state. One notable collaborator was John Wright of Charleville. Her last course was in 1998, at the age of 80. For these courses Pat produced the 'green book', *An Atlas of Common Queensland Mosquitoes* (Marks 1966), familiar to local authority personnel working with mosquitoes, first published in 1966, revised in 1967, 1973 and rewritten for the 1998 course. Pat appreciated that many of the students would not have access to a dissecting microscope and wrote the descriptions emphasising characters which could be seen with a hand lens. Clearly this showed an appreciation of what happened in the field.

Early in 1949 she was granted extended leave and travelled to the United Kingdom, where she completed a PhD at Cambridge in 1951. In the UK she mixed with the greats of the mosquito world - Mattingly, Buxton, Smart, Wigglesworth and Christophers - who must have seen a great potential mosquito worker in this lady from Australia.

Pat resumed duty with the Mosquito Control Committee in Brisbane in late 1951 and was almost immediately sent to Mildura, on the Murray River in Victoria, to participate in an investigation of Murray Valley Encephalitis by a team headed by Dr Bill Reeves, a US expert with experience in working with mosquito-borne viruses. Another member of the team was Dr M. Josephine Mackerras, an outstanding scientist, parasitologist and entomologist, daughter of early Queensland physician and mosquito worker Thomas Lane Bancroft, and wife of Ian Mackerras. Her portrait, as Major Mackerras, hangs in the Australian War Memorial to commemorate her outstanding contribution to the wartime Australian research on malaria.

Although no virus was isolated from the mosquitoes collected at Mildura, the experience gained was put to good use eight years later when Pat and Josephine Mackerras participated in expeditions to Mitchell River mission (now Kowanyama), led by Dr R.L. Doherty of the Queensland Institute of Medical Research (QIMR). The mosquitoes they collected yielded Murray Valley Encephalitis virus, along with at least eight other viruses new to science, results which guaranteed the continuation of the QIMR Arbovirus Research Programme.

In 1958 Pat spent three months collecting mosquitoes in New Guinea, supported by the Bernice P. Bishop Museum in Hawaii. She travelled widely to remote villages by small planes and rivercraft, mostly in the then Australian Territory of Papua New Guinea but she also had the opportunity to visit then Dutch New Guinea [now the Indonesian Province of West Papua] and made a long journey up the Mamberano River (Fig. 3) with Dutch entomologist, Hans van den Assem. The mosquitoes of New Guinea were a continuing interest and she visited the area four more times during her career.

In 1962 Pat moved with the Entomology Department when it relocated from George Street to the St Lucia campus of the University of Queensland. It was my impression that Pat was happiest in the university environment in the company of other entomologists and interacting with postgraduate students. Pat seems to have had much the same opinion: 'I had moved with the University to St Lucia where I worked in the Goddard Building, which was shared with the Zoology Department. I had a lovely big room there and I think I did my best work in that room' (Marks and Cummins 2004, p. 145).

Table 1 summarises some of Pat's activities. In the period spent at the University of Queensland, she described 37 new species of mosquito (see Appendix), collected a further 43 species she considered to be new, allocating species numbers to them and putting them aside for later study. The days of describing a new species from one specimen had long gone, so lack of adequate material, both male and female, may have been one factor, while lack of link-reared larvae and pupae may have been another.

Table 1. Productivity of E.N. Marks during different phases of her career.

LOCATION	Queensland University (George Street)	Queensland University (St Lucia)	Queensland Institute of Medical Research
Period	1940 – 1961	1962 – 1976	1977 – 1983
Published papers	39 mosquitoes 2 other	37 mosquitoes 28 other	18 mosquitoes 7 other
New species described	27	10	1
New species allocated Marks code numbers	9	34	17

Pat usually published new species in related groups with a review of the relationships within the group; occasionally she published single species. In 1954 she published a review of the *Aedes scutellaris* subgroup, which contained a number of closely related and morphologically similar species. The group was of medical importance, as it contained vectors of both filariasis and dengue fever and was widely distributed in the Pacific. In studying the group, Pat noted that one species, *Aedes pseudoscutellaris* (Theobald), was a mixture of two species and named the new species *Ae. polynesiensis* Marks, publishing it alone, as it was important to rapidly spread the news. *Aedes polynesiensis* was shown to be a good vector of both filariasis and dengue. While Pat solved a species problem she produced one for the epidemiologists: which species had they been working with all these years?

When I started working with mosquitoes in 1953, Edwards (1925) was the standard text, supplemented by wartime handbooks. Many of the descriptions in Edwards were brief and inadequate. I remember Pat describing them as 'heads and tails'. Pat changed this - her descriptions covered the whole insect in great detail, both male and female, often including descriptions of larvae and pupae. When appropriate, she would review the genus or subgenus, producing keys to adults and larvae and including notes on the breeding sites and distribution.

When it came to Pat's research, I and many of my colleagues were, and still are, end users. Our aim was to collect as many mosquitoes as possible, identify them to species while still alive, freeze them in liquid nitrogen, then homogenise them and inoculate them into tissue culture or day old mice - not quite the way Pat was used to treating her pets.

In conclusion I have many memories of working with Pat, who never considered herself infallible. Many of us were certain she was. On one occasion, after the Pacific Science Congress in Dunedin, New Zealand, I was interested in what I considered to be the odd distribution of *Culex annulirostris* Skuse in the Pacific. I told Pat I had serious doubts about the validity of many of the identifications, except for one island group where the mosquitoes had been identified long ago by Miss E.N. Marks. Pat's reply was 'Harry, what makes you think I knew what *annulirostris* was in those days?'

Pat has left a legacy which places every mosquito worker in Australia in her debt. Her descriptions of new species and redescriptions of poorly described species, together with revisions of sub-genera and species groups and the numerous keys in the *Culicidae of the Australasian Region*, ensures that we are continually referring to works by E.N. Marks.

I find it difficult to do justice to Dr E.N. Marks with such a brief note except to say that I was enriched both as a person and as a scientist by knowing her and I sorely miss being able to solve my problems by 'going to see Pat.'

References

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Appendix

New species of mosquitoes described by E.N. Marks

Species are arranged chronologically by year of description and are cited in their original combination. Country of type locality is given and those where the holotype was collected by E.N. Marks are indicated with *.

Aedes (Finlaya) bougainvillensis Marks, 1947. Solomon Islands.

Aedes (Finlaya) fijiensis Marks, 1947. Fiji.

Aedes (Finlaya) alocasicola Marks, 1947. Queensland.

Aedes (Finlaya) gahnicola Marks, 1947. Queensland.

Aedes (Finlaya) candidoscutellum Marks, 1947. Queensland.

Aedes (Finlaya) wasselli Marks, 1947. Queensland.

**Aedes (Finlaya) monocellatus* Marks, 1948. Queensland.

Aedes (Finlaya) subauridorsum Marks, 1948. Queensland.

Aedes (Ochlerotatus) pseudonormanensis Marks, 1949. Queensland.

Aedes (Ochlerotatus) perkinsi Marks, 1949. Queensland.

Aedes (Stegomyia) polynesiensis Marks, 1951. Fiji.

Aedes (Finlaya) iwi Marks, 1955. Queensland.

Culex (Neoculex) cheesmanae Mattingly and Marks, 1955. New Caledonia.

**Anopheles (Anopheles) colledgei* Marks, 1956. Queensland.

Aedes (Stegomyia) upolensis Marks, 1957. Samoa.

Aedes (Ochlerotatus) calcariae Marks, 1957. South Australia.

Aedes (Finlaya) britteni Marks and Hodgman, 1958. Western Australia.

**Aedes (Finlaya) josephinae* Marks, 1958. Queensland.

Aedes (Finlaya) dobrotworskyi Marks, 1958. Victoria.

Aedes (Ochlerotatus) hodgkini Marks, 1959. Western Australia.

Aedes (Ochlerotatus) macintoshi Marks, 1959. Western Australia.

Aedes (Ochlerotatus) ratcliffei Marks, 1959. Western Australia.

Aedes (Ochlerotatus) hesperonotius Marks, 1959. Western Australia.

Aedes (Ochlerotatus) purpureifemur Marks, 1959. Western Australia.

Aedes (Finlaya) plagosus Marks, 1959. New South Wales.

**Topomyia papuensis* Marks, 1960. Papua New Guinea.

Aedes (Ochlerotatus) subalbirostris Klein and Marks, 1960. New Zealand.

Aedes (Chaetocruomyia) calabyi Marks, 1963. Western Australia.

Aedes (Ochlerotatus) spilotus Marks, 1963. Victoria.

Aedes (Ochlerotatus) turneri Marks, 1963. Western Australia.

Aedes (Ochlerotatus) cacozelus Marks, 1963. Western Australia.

Aedes (Chaetocruomyia) macmillani Marks, 1964. New South Wales.

**Aedes (Ochlerotatus) explorator* Marks, 1964. Northern Territory.

Aedes (Ochlerotatus) linesi Marks, 1964. South Australia.

Aedes (Ochlerotatus) phaecasiatus Marks, 1964. Northern Territory.

Aedes (Ochlerotatus) sapiens Marks, 1964. New South Wales.

**Culiseta arenivaga* Marks, 1968. Queensland.

Aedes (Macleaya) stoneorum Marks, 1977. Queensland.